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PHYSIOLOGICAL AND PSYCHOLOGICAL CHARACTERISTICS AMONG COMPETITIVE ROWERS

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Abstract

Introduction: Elite rowing athletes participated in anthropometric, psychological and physiological tests.
Aim: This study aimed to investigate the relations between the traits of sport-confidence and competitive orientation, as well as to compare state measures of sport-confidence, self-efficacy and anxiety. Furthermore, this study targeted to examine the associations of these state measures with performance, in our case the 2000m rowing ergometer run time.
Material and methods: Rowers (N=15) were subjected to anthropometric, psychological and physiological tests: max 2000 m on Rowing Ergo-test, Athletic Coping Skills Inventory-28, Competitive State Anxiety Inventory-2 and Sport Competition Anxiety Test.
Results: CSAI-self-confidence showed a statistically significant difference between genders with boys having a higher score. Overall, SCAT (anxiety) scores were low (normal anxiety) in the sample for the vast majority (12 rowers), only 3 participants showed high anxiety.
Conclusion: The psychological profile does not contribute significantly performance on 2000m Rowing Ergo-test but affects it. Girls completed the distance in a longer period of time, and cognitive anxiety was relatively greater among girls. Additionally, our study pointed out that if the physical parameters are 'inadequate,' then the psychological profile does not contribute to better performance.

Keywords: *rowing, anxiety, psychological profile, physiological characteristics*

INTRODUCTION

It is critical to identify any psychological factors related to endurance performance. The psychobiological model predicts that any psychological or physiological factor that increases potential motivation or reduces perception of effort will improve endurance performance. A psychological or physiological factor that reduces potential motivation or increases perception of effort will erode endurance performance (MARCORA, 2010; SARKAR – FLETCHER, 2014).

Related literature suggest that many athletes are concerned about the competitive outcomes. Although the desire to win can sometimes be a beneficial behavior, it can also have negative consequences (ORLICK, 1986). Specifically, athletes with unrealistic goals often experience low self-confidence, high anxiety and ultimately poor performance. In contrast, athletes who strive to perform well in their sport appear more confident, less anxious and may be more likely to reach their potential (MARTENS, 1987). Some experiential knowledge suggests these tendencies, however, only few empirical studies have been conducted (VEALEY, 1986; VEALEY 1988). The athlete's interpretations determine the emotions and associated somatic and cognitive symptoms that the athlete experiences in response to the stressor (MARTINENT – FERRAND, 2015; UPHILL – JONES, 2007). Following the emotional response, it is proposed that the athletes evaluate whether the emotion is relevant to their performance (tertiary interpretations) and what options they have to cope with (quaternary interpretations). The athlete's perceived ability to control and manage the emotional response is suggested to determine whether the athlete discerns it as facilitative or debilitative to their performance.

Anxiety has densely been cited as having an essential role in athletics. (BURTON, 1989) and (GOULD et al., 2003) suggested that cognitive anxiety (worry) is negatively related to self-confidence. Finally, related research and self-reflection of athletes have suggested that self-confidence and anxiety influence performance (GANT – COX, 2004). Self-confidence enhances performance, whereas cognitive anxiety impairs it (FELTZ, 1988).

This study aimed to investigate the relations between the traits of sport-confidence and competitive orientation, as well as to compare state measures of sport-confidence, self-efficacy and anxiety, furthermore, to examine the associations of these state measures with performance, in our case the 2000 m rowing ergometer run time.

MATERIAL AND METHODS

PARTICIPANTS

15 participants (6 boys, 9 girls), aged between 15 and 18 years (M = 16.1, SD = 1), with training age between 1 and 7 years (M = 4.2, SD = 1.9) were included in this study. The following inclusion criteria were applied in the targeted sampling procedure: rowers in all age groups had to hold a valid competition license and participate in national and international competitions for at least one year. All rowers had valid medical certificates, and they regularly participated in trainings. Additionally, they did not limit their physical activity levels (for whatever reason) to the extent that could significantly affect their physical fitness. The training program was consistent with the Hungarian Rowing Federation Training Routine guidelines: 12-13 hours/week for 15- to 16-year-olds, 14-15 hours/week for 17- to 18-year-olds, and 16-17 hours/week for 19- to 22-year-olds. The aerobic-to-anaerobic training ratio in the above groups was 80:20 percent, 75:25 and 70:30 percent, respectively. Athletes with an international ranking participated in training camps organized by the Hungarian Rowing Federation two to three times a year (depending on age group). This research was conducted according to the guidelines and policies of the Health Science Council, Scientific and Research Ethics Committee (IV / 3067-3 / 2021 / EKU), Hungary, and in following the Declaration of Helsinki. Each participant was provided with detailed information about the purpose, potential risks and measurement methods of the study. All rowers gave voluntary informed consent to participate in the study by signing the consent forms.

PROCEDURES, DATA COLLECTION AND EQUIPMENT

Each rower performed selected anthropometric and physiological tests in the middle of the 2020 racing season. On day one, anthropometric features were measured; on day two, the athletes performed additional tests, while on day three, they covered a distance of

2000 m on rowing ergometer. The coaches in charge of the rowers in the sports clubs helped us with the measurements. At all times, the coaches were instructed not to engage the subjects in any strenuous training the day before the testing took place. Body mass (BM) was measured to the nearest 0.1 kg, body height was measured to the nearest 0.1 cm. Body Mass Index (BMI) is a simple calculation using a person's height and body weight. The formula is BMI = kg/m^2, where kg is a person's weight in kilogram and m^2 is their height in square metre. The remaining anthropometric characteristics, such as arm span [cm] were measured using international standards developed by the International Society of Advancement of Kinanthropometry (ISAK) (MARFELL – OLDS, 2006).

2000 M MAXIMAL ROWING ERGOMETER TEST

The participants were asked to perform an all-out 2000 m test on a certified rowing ergometer (Concept 2 D-model). The Concept2 RowErg® sets the standard for indoor rowing machines. This is the same machine used by Olympic- and elite-level athletes to train for their sport, but it is also popular among people of all ages and abilities worldwide, who want a total-body, low-impact workout.

Prior to all tests, each participant warmed up for 6 minutes on a 500 m distance. Participants rested for 6 minutes, while performing stretching exercises. The ergometer screen was set to display the remaining meters, the average 500 m split time and the accumulated time. The power output in watts (W) was measured over 2000 m. The Watts calculation was performed in the following way: First, the distance was defined as *distance = (time / number of strokes) × 500*. In the next step, the concept of a “split” was clarified: *split = 500 × (time / distance)*. The watts were calculated as *watts = 2.8 / (split / 500)*. There were slight differences in intensity due to personal changes in stroke value and the ability to keep the 500 m split time constant. The estimated relative aerobic capacity (ErVO2) was calculated by using the formula of McArdle et al. (2006) for men: ErVO2 = (Y × 1000) / BM, where BM is body mass in kilograms, and Y = [BM <75kg; 15.1- (1.5 × time); BM ≥ 75kg; 15.7- (1.5 × time)].

SPORT COMPETITION ANXIETY TEST (SCAT)

The Sport Competition Anxiety Test (MARTENS, 1987), commonly known as SCAT test, is a self-reporting questionnaire about anxiety. The SCAT analyses an athletes’ responses to a series of statements about how they feel in a competitive situation. From the results, it is possible to determine their level of anxiety.

PROCEDURE

There was no time limit to answer the 15 questions in the SCAT test questionnaire. The test was suitable to monitor the performance anxiety of an athlete.

ATHLETIC COPING SKILLS INVENTORY-28 (ACSI-28)

The Athletic Coping Skills Inventory-28 (ACSI-28) is a refined psychology assessment, used in several previous studies to measure individual differences in psychological skills within a sport context. ACSI-28 was developed utilizing a psychometric strategy that involved the use of confirmatory factor analysis to derive subscales that conformed closely to an underlying structural model of psychological skills. The ACSI was initially developed in the mid-1980s as part of a research project on psychosocial vulnerability and resiliency factors related to athletic injury. The study design supported the characteristics of life stress, social support and psychological coping skills (SMITH – SMOLL, 1990). To measure the latter variable, we utilized a scale measuring individual differences in general psychological and specific psychological skills such as stress management, concentration, control of worry and mental preparation.

COMPETITIVE STATE ANXIETY INVENTORY-2 (CSAI-2)

The test is a sport-specific measure of the competitive state anxiety subcomponents of somatic and cognitive anxiety. Thus, CSAI-2 measures the separate components of state somatic anxiety, mental anxiety and self-confidence (GANT – COX, 2004). Athletes are asked to indicate "how you feel right now" for each item on a 4-point Likert scale ranging from "not at all" to "very much so". Each of the three subscales has nine items. The total score represents how intensively the athlete feels for each component of anxiety and for the self-confidence about performing. The participants rated the perceived intensity of their feelings on a 7-point scale ranging from -3 (too much debilitative) to +3 (too much facilitative). Hence, scores ranging from -27 to +27 for each of the cognitive anxiety, somatic anxiety and the self-confidence.

TRAIT SPORT CONFIDENCE IINVENTORY (TSCI)

The Trait Sport Confidence Inventory (TSCI) was developed to assess how confident athletes generally feel when they compete in sport. Items on the inventory ask the participants to compare themselves to the "most confident athlete you know". The inventory consists of 13 items with no subscale components, utilizing a 9-point Likert scale anchored by 1 (low) and 9 (high). An item of the TSCI read "Compare your confidence in your ability to perform under pressure to the most confident athlete you know". The item scores represent low (scores from 1 to 3), moderate (scores from 4 to 6) or high (scores from 7 to 9) confidence. Trait sport confidence scores are obtained by a mean score or a total score. Total scores between 13 and 39 reflect a low level and scores between 91 and 117 demonstrates a high level of overall competition confidence.

STATISTICAL ANALYSIS

Basic statistical measures (e.g., mean (M), standard deviation (SD)) were calculated and the normality of the distributions was assessed. Since the distributions did not differ significantly from normality (Shapiro-Wilk test), Student's t-test was used to determine the differences between boys and girls. Linear regression analyses were employed to constitute two different prediction models. We used anthropometric measurement results (arm span, BMI), physiological parameters (resting pulse (rP), estimated aerobic capacity ($ErVO_{2max}$), Peak power (PP in Watts)) and psychological variables (SCAT, ACSI, CSAI, TSCI). The variables that resulted in the lowest possible standard error of estimate (SEE) were used for all equations. R^2 and the SEE expressed reliability of the regression models. The adjusted R^2, as opposed to the sample R^2, was used to assess the proportion of variance that could be explained by the independent variables.

RESULTS

DESCRIPTIVE STATISTICS

The participants were six males and nine females, aged between 15 and 18 years (M = 16.1, SD = 1), with training age between 1 and 7 years (M = 4.2, SD = 1.9). There was no statistically significant difference in the age of boys (M = 16, SD = 0.9) and girls (M = 16.2, SD = 1.1) ($t(13) = -0.431$, $p = 0.647$). By training age, boys were older (M = 6, SD = 0.6) than girls (M = 3, SD = 1.3) ($t(13) = 5.871$, $p < 0.001$).

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Table 1: Anthropometric and physical variables for the total sample of males and females (Abbreviation: Time 2000 m [min] = time of the 2000 m rowing ergometer test, $ErVO_2$ max [mL/kg/min] = estimated relative maximal aerobic capacity, PP [W] = calculated power output in watts at the peak of the performance, BMI = Body Mass Index, rP = resting pulse [beat/min].)

	Total (N=15)				Males (n=6)		Females (n=9)		t	p
	Min.	Max.	M	SD	M	SD	M	SD		
Time 2000 m [sec.]	395,00	497,00	453,27	36,72	414,17	21,69	479,33	12,44	-6,664	< 0,001
BMI [kg/m^2]	20,20	24,40	22,07	1,11	21,70	0,96	22,31	1,19	-1,094	0,295
Arm span [cm]	160,10	200,00	179,30	10,00	186,05	8,46	174,80	8,55	2,512	0,029
rP [beat/min]	69,00	85,00	78,07	4,88	78,17	5,74	78,00	4,58	0,06	0,954
PP [W]	183,00	364,00	250,33	65,75	319,83	44,88	204,00	16,36	6,06	0,001
$ErVO_{2max}$ [mL/kg/min]	43,24	69,53	54,50	7,28	61,19	5,07	50,05	4,56	4,339	0,001

Source: own result

Girls completed the 2000 m distance in a significantly longer time (414.2±21.7 - 479.3±12.4 sec) than the boys did. They also had lower aerobic capacity (61.2±5.07 - 50.05±4.56 mL/kg/min) and lower power output at peak of the exercise (319.8±44.8 - 204.0±16.4 W). No significant difference was found between BMI and resting heart rate (rP) averages (*Table 1*).

Table 2: Psychological variables for the total sample of males and females

	Total (N=15)				Males (n=6)		Females (n=9)		t	p
	Min.	Max.	M	SD	M	SD	M	SD		
SCAT_MARTENS	17	26	22,47	2,29	22,33	1,21	22,56	2,88	-0,206	0,840
ACSI_COPING_ CAPACITY_SUM_H	58	95	79,47	10,25	80,50	12,94	78,78	8,81	0,285	0,783
CSAI Cognitive_anxiety	11	31	23,13	5,97	19,33	5,89	25,67	4,77	-2,198	0,055
CSAI_Somatic_anxiety	15	30	23,33	5,39	20,00	4,94	25,56	4,67	-2,181	0,053
CSAI_Self-confidence	16	35	24,47	6,00	28,33	5,47	21,89	5,06	2,304	**0,043**
Trait_Sport-Confidence_ Inventory_sum	55	112	95,00	15,83	101,67	9,50	90,56	18,06	1,551	0,146

Source: own result

Only the CSAI-self-confidence showed a statistically significant difference between genders as boys having higher score. Overall, SCAT (anxiety) scores were low in the sample, the vast majority (12) with normal anxiety and 3 with high anxiety. ACSI (coping capacity) scores were relatively high, averaging 71% of the total score (SD = 9.1%). CSAI Cognitive Anxiety and Somatic Anxiety scores indicated rather higher than moderate levels of anxiety, averaging 64.3% (SD = 16.6%) of the total score for cognitive anxiety and 64.8% (SD = 15%) for somatic anxiety. The CSAI self-efficacy score indicates greater than medium self-efficacy, with 68% (SD = 16.7%) of the total score. Sport self-confidence scores were relatively high across the sample, with the vast majority, 13 participants, showing high self-confidence and 2 participants showing medium self-confidence (*Table 2*).

FIRST SCHEME

Table 3: Predictability based on physical parameters

	B	SE	Beta	t	p

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Age [year]	-14,491	6,083	-0,391	-2,382	**0,038**
BMI [kg/m^2]	8,859	5,392	0,268	1,643	0,131
rP [beat/min]	-0,159	1,123	-0,021	-0,141	0,891
gender× ErVO$_{2max}$	1,435	0,261	0,825	5,495	**< 0,001**

Source: own result

Dependent variable: 'Time 2000 m (sec.)'. Independent variables: age, BMI, heart rate, gender×ErVO2$_{max}$. One of the criteria for regression models is multicollinearity, i.e. no correlation between independent variables above 0.5-0.7. Since arm span and watt (0.760); watt and ErVO2$_{max}$ (0.815); arm span and ErVO2$_{max}$ (0.595) do not meet the regression fit conditions, the solution was to choose the estimated aerobic capacity ErVO2$_{max}$. The non-deterministic is related to the dependent variable, so the solution may be to treat males and females together. In this scheme, the conditions are met: the model is significant (F(4,10) = 8.831, p = 0.003). Model power and prediction: 77.9% (R^2 = 0.779, R^2_{ajd} = 0.691). Age is significant (t(11) = -2.382, p = 0.007). One unit increase in age reduces time by -14.491. Gender×rVO$_{2max}$ is significant (t(11) = 5.495, p < 0.001) (*Table 3*).

SECOND SCHEME

Table 4: Predictability based on psychological profile

	B	SE	Beta	t	p
Age [year]	-7,701	4,497	-0,208	-1,713	0,121
SCAT	-6,227	2,103	-0,389	-2,961	**0,016**
ACSI	0,522	0,512	0,146	1,020	0,335
TSCI	-0,538	0,370	-0,232	-1,454	0,180
gender×cognitive anxiety	1,791	0,279	0,883	6,414	**< 0,001**

Source: own result

Dependent variable: 'Time 2000 m (sec.)', Independent variables: ‘age, SCAT, ACSI, CSAI cognitive, somatic, self-confidence, TSCI’. Some independent variables, measuring very similar constructs, should be omitted from the model. Based on this consideration: Individual factors of CSAI are unsurprisingly correlated: cognitive anxiety - somatic anxiety: 0.805; cognitive anxiety - self-consciousness: -0.821; somatic anxiety - self-consciousness: -0.877.

CSAI self-confidence and TSCI: 0.549, no relationship with other CSAIs. No relationship between ACSI and CSAI, no relationship between SCAT and TSCI.

Based on the above, it is recommended to include the following variables in the analysis: ACSI (coping capacity), CSAI cognitive anxiety, SCAT (~somatic anxiety), TSCI (~self-confidence), age and gender.

In this model, the conditions are met: Model is significant (F(5,9) = 11.912, p = 0.001. Model power and prediction: 86.9% (R2 = 0.869, R2ajd = 0.796). SCAT is significant (t(10) = -2.961, p = 0.016). One unit shift in SCAT reduces time by -6.227. Of the two significant independent variables, cognitive anxiety has greater explanatory power: (B = 0.883; SCAT: B = 0.389) (*Table 4*).

CONCLUSIONS

The main influencing factors on the result of the 2000m performance are age, gender and $ErVO_{2max}$, which explain nearly 80% of the variability in results of the rowing tests. Time decreases with increasing age; time is greater for females and $ErVO_{2max}$ is decreased in case of females. Furthermore, time decreases with increasing $ErVO_{2max}$. The inclusion of the psychological profile does not significantly contribute to explaining the variability of time.
The psychological profile affects time variability, with time decreasing as SCAT increases, time being more significant factor among girls, cognitive anxiety being relatively greater among girls and performance decreases as anxiety increases (WEINBERG – GENUCHI, 1980). However, if the physical performance characteristics demonstrate a lower level of physical fitness the psychological profile does not contribute to better performance.

LIMITATIONS OF THE STUDY

There are a relatively small number of athletes participated in the study. Generalization of the results is limited due to restricted number of male and female participants.

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